High resolution color holography of the crustal structures by means of elastic and electromagnetic ACROSS: A perspective view

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ACROSS is an acronym of ‘accurately controlled, routinely operated signal system’, which is being used to detect the subtle temporal variation of the underground structures by elastic wave signal. Whereas seismic ACROSS has been deployed at serval sites, complementary electromagnetic ACROSS has not been payed attention to be implemented. Furthermore, currently operating seismic ACROSS does not appear to exert its high potentiality expected theoretically. Recognizing the substantial potentiality of the simultaneous implementation of both seismic and electromagnetic ACROSS, the present author has kept working with several coworkers towards the better implementation strategy of ACROSS technology.
Recently (2014) we convinced to have found a reasonable way to utilize the potentiality of ACROSS, and started to work with ERI and ELSI (TITECH) to design the detailed tactics and strategy. We have a set of two important factors: (1) designing of implementation technology of ACROSS and (2) development of an ‘operational digital wave theory’ expected to enable us to invert the big data acquired by ACROSS to ‘color holography movie of anisotropy’.
The current state of technology and its prospect are reported in this presentation.
(1) A dense array of both seismic and magnetic sensors combined with a sparse transmitter array of seismic and electromagnetic waves would provide us with such observation data on anisotropy and color (frequency dependence) holography of the crustal structures. As a matter of course, spatial resolution of color and anisotropy depends on the designing of the observation system, frequency range of operation, and also on the time period of data acquisition.
(2) An operational digital wave (ODW) theory developed in this work is quite different from the routine method commonly used on the basis of finite difference approach on wave equation with a weak form. By introducing a hyper-function calculus, differential equations of both elastic and electromagnetic waves are converted to the algebraic equation in wavenumber space in ODW theory. By introducing a sequence of finite discrete coordinates, an efficient iterative innovation strategy is realized for both forwards and inverse computations.
A set of ACROSS technology and ODW theory would promote the transition of the current ‘phenomenological dynamics’ to the qualified dynamics based on the physical properties of material under tectonic stress with sound physics and observation background. A good test field may be the source area of the 2000 Western Tottori Earthquake, where fluid migration dynamics along the subsurface fault zone may be traced through the observation of temporal variation in the anisotropy of conductivity and polarized shear wave velocities. Note that the high quality observation is essential for the modern tectonics studies.

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